ACE-FTS Version 3.0 Validation Update

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Introduction

Long-time series of atmospheric measurements are required to monitor and study the atmosphere. To facilitate the production of these time series, the biases between different instruments need to be quantified for coincidence period.

ACE-FTS

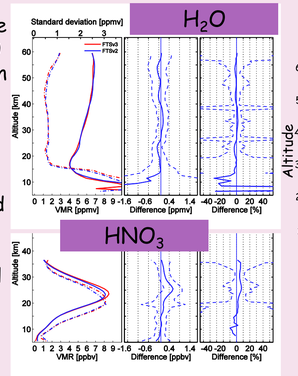
The ACE-FTS is a high resolution (0.02 cm^{-1}) Fourier transform spectrometer which measurements over the 750-4400 cm^{-1} (2.2 to 13.3 μm) spectral region using solar occultation geometry. It is one of two instruments on-board the Canadian SCISAT-1 satellite which was launched on the 12 August 2003 (Bernath et al., 2005) and has now been making measurements for over 8 years. ACE-FTS produces profiles of atmospheric temperature and more than 30 trace gas species(Boone et al., 2005) over a latitude range of ~85°N to ~85°S.

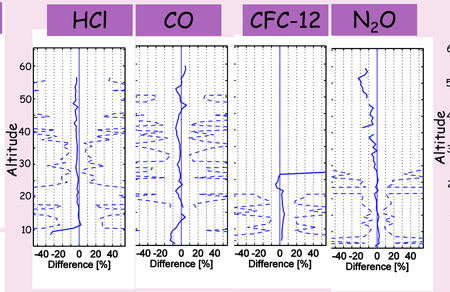
Direct ACE-FTS Version comparisons

To identify specific changes between processing versions direct comparisons have been made between the current version 3.0 (v3) with the previous well-validated version 2.2 + updates dataset (v2.2) .

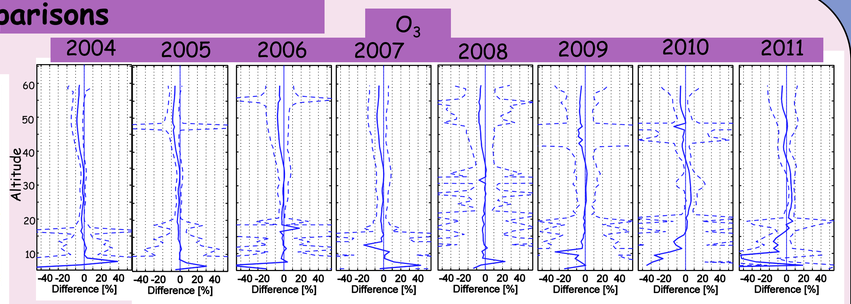
The mean profiles, absolute differences (v3.0 – v2.2) and relative differences are calculated along with the standard deviations. These comparisons are produced for the ACE-FTS data from 2004 to 2011, they are produced for the full latitude range of the data (~85°N to ~ 85°S) as well as for selected latitude bands.

Examples of these comparisons for H_2O and HNO_3 are show to the right.





A few more examples of the percentage differences between v3.0 and v2.2 are show above.



The percentage difference plots are shown above for ozone for each year shown individually. These differences are quite consistent for most years, with all years seeing quite large variation below ~20 km. Above ~20 km, the 2008 have a larger variations than the other years. This is due to outliers which we are currently in the process of characterizing and filtering out.

Aura-MLS

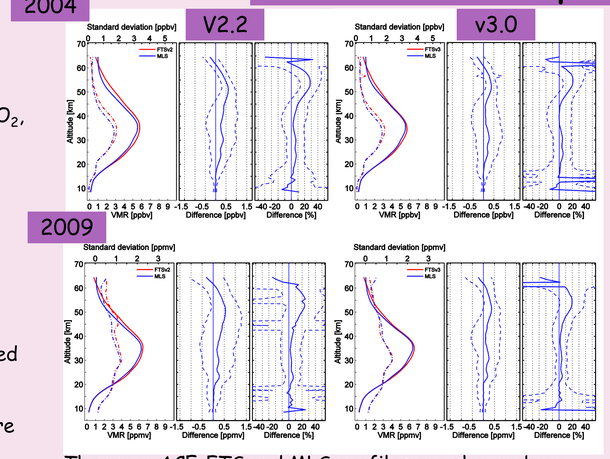
Aura-MLS was launched on 15th July 2004 on the Aura satellite and it obtains global coverage on a daily basis. It measures temperature and the concentrations of H_2O, O_3, ClO, BrO, HCl, OH, HO_2, HNO_3, HCN, and N_2O using thermal microwave emisions from the limb of the atmosphere.

Correlative Data

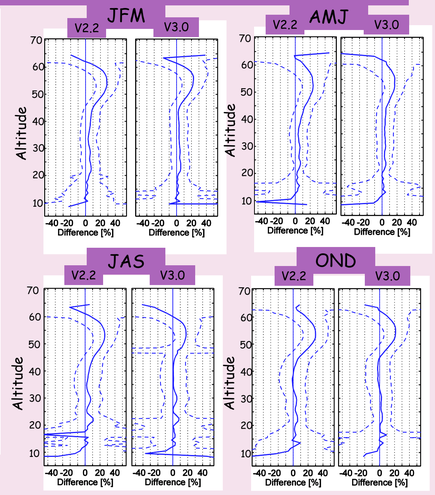
Coincidences between the two datasets were defined by the criteria that the occultations be within ±5° in latitude and ±10° in longitude and occur within ± 6 hours.

The new MLS Version 3 dataset has been compared to both the ACE-FTS V2.2 and ACE-FTS V3.0 data forthe full latitude range of the ACE-FTS data (~85°N to ~ 85°S). Initially comparisons were produced 2009 data and are now currently being produce for 2004-2011 data.

ACE-FTS comparisons with Aura-MLS

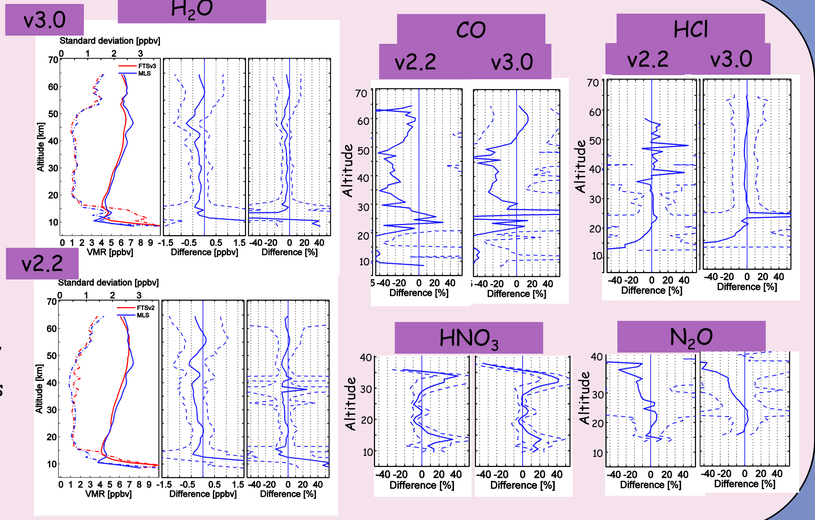


The mean ACE-FTS and MLS profiles are shown above, along with the absolute and relative differences for O_3.



To the left, the percentage differences are show for 2005 ozone data split into 3 month subsets.

To the right, the ACE-FTS comparisons with the 2009 Aura-MLS data subset are shown. The mean ACE-FTS and MLS profiles are shown, along with the absolute and relative differences for H_2O. The percentage differences are show for CO, HCl, HNO_3 and N_2O.

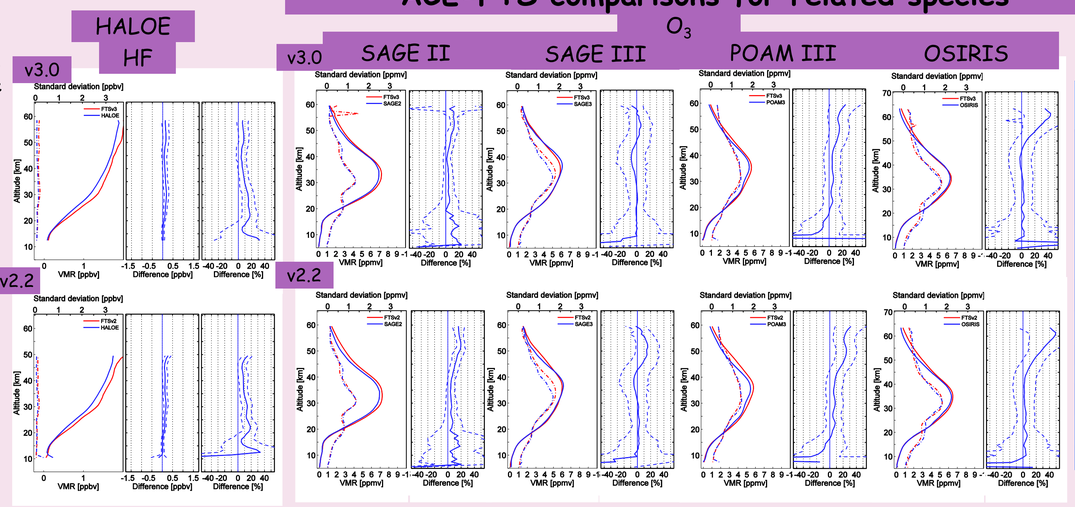


ACE-FTS comparisons for related species

As well as Aura-MLS, the ACE-FTS data is compared to several other satellite instruments. The details of the satellite instruments datasets which the ACE-FTS dataset is validated against are show in the table below.

Instrument name	Data Version	Measurement type	Species	Overlap with ACE
MLS	v3.3	Limb emission	O_3, CO, H_2O, HCl, HNO_3 and N_2O	2004-Present
SAGE II	v6.2	Occultation	O_3 and NO_2	2004-2005
SAGE III	v3.0	Occultation	O_3 and NO_2	2004-2005
POAM III	v4	Occultation	O_3 and NO_2	2004-2005
HALOE	v19	Occultation	O_3, NO_2, HCl, HF, H_2O, NO and CH_4	2004-2005
OSIRIS	v2.1	Limb scattering	O_3 and NO_2	2004-Present

To the right a few examples are shown for ACE-FTS comparisons with HALOE, SAGE II, SAGE III, POAM III and OSIRIS.



The table above summarizes the results see for the full list of inter-instrument comparisons.

Species	Instrument comparisons	Comment
O_3	HALOE, SAGE II, SAGE III, POAM III, OSIRIS and MLS	For HALOE comparisons a notable improvement of ~5% can be seen in the ~35-50 km region. There is a reduction in these differences of ~5% below the ozone peak at ~35 km and ~10% above the peak, for the v3.0 comparison compared to the v2.2. comparison in the MLS comparisons.
NO_2	HALOE, SAGE II, SAGE III, POAM III, and OSIRIS	Generally the ACE-FTS v3.0 data improves the agreement between ACE and the coincident instruments.
HCl	HALOE and MLS	The percentage differences are smoothed out and The standard deviation in the differences can be seen to be reduced in the MLS comparisons. In the HALOE comparisons the altitude range has been extended to ~60 km for the v3.0 dataset. A reduction in the bias of ~5% can be seen for the higher altitudes above ~35 km
HF	HALOE	The altitude range has been extended to ~60 km for the v3.0 dataset. A reduction in the bias of ~5% can be seen for the higher altitudes above ~35 km.
H_2O	HALOE and MLS	For the MLS comparisons the difference profile is smoother for v3.0 compared to v2.2, leading to a more constant offset of ~5% between the instruments for the altitude range ~20km to ~40km.
NO	HALOE	From ~30km to ~40km the agreement is improved by ~2-3%
CH_4	HALOE	For CH_4 an improvement of ~5% can be seen in the ~35-40 km region.
CO	MLS	In areas above ~30km the percentage differences are smoothed out slightly. Improvement in the standard deviation
HNO_3	MLS	For the altitude range ~15km to ~30km the differences between ACE and MLS are shifted ~5% in the positive direction, improving the agreement between the two instruments in these regions.
N_2O	MLS	The differences are reduces in the altitude range ~15km to ~25km from ~9% to 5%.

Conclusions

- In general, the v3.0 ACE-FTS dataset compares better to the MLS and other coincident satellite instrument data sets than v2.2.
- The direct version comparisons the VMR reductions seen in most of the v3.0 dataset, compared to the v2.2 dataset, are consistent with the need to reduce the bias seen in the v2.2 validation studies.

Acknowledgements

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References

- Bernath et al., Atmospheric Chemistry Experiment(ACE): Mission overview, Geophys. Res. Lett., 32, L15501, doi:10.1029/2005GL022386, 2005.
- Boone et al., Retrievals for the Atmospheric Chemistry Experiment Fourier-transform spectrometer,Appl. Optics, 44(33), 7218-7231, 2005.